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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/061,218	02/04/2002	Masao Someya	42261	2110

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EXAMINER
LISH, PETER J

ART UNIT	PAPER NUMBER
1754	8

DATE MAILED: 06/02/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/061,218	SOMEYA ET AL.	
	Examiner	Art Unit	
	Peter J Lish	1754	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02/02/2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-15 and 20-31* is/are rejected.

7)☒ Claim(s) *16-19* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *5* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 5 and 25 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. a) In claim 5, the thickness of the coating is limited to a range of 0.05 nm to 5 microns. Claim 5 depends on claim 4, however, which limits the thickness of the coating to a range of 5 nm to 100 microns. A thickness of 0.05 nm, therefore, meets the range of claim 5 without meeting the range of the claim to which it depends, making it indefinite. b) Claim 25 states that the support is dried before the aluminum coating is applied. However, claim 25 depends upon claim 13 and, through 13, to claim 1. Nowhere is an aluminum coating stated. It is indefinite as to whether this aluminum coating is an additional limitation of claim 25.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-7, 10-16, 21-23, and 26-29 are rejected under 35 U.S.C. 102(e) as being anticipated by Iwasaki et al. (USPN 6,278,231).

Iwasaki et al. teach a method for producing aligned nanotube films which comprises forming a film of aluminum on a ceramic substrate, loading the film with catalytic metal, and growing carbon nanotubes by a chemical vapor deposition process using ethylene at a temperature of 700°C (column 19, lines 21-50). The aluminum film is deposited by sputtering (column 15, lines 25-27) and the cobalt metal catalyst is electrochemically deposited using an aqueous solution of cobalt sulfate. The film thickness is controlled between 10nm and 100 micron (column 9, lines 50-60). Regarding the structure of the ceramic substrate, when a substrate having silicon is employed, the silicon is converted to porous silicon oxide during the formation of the nanopores in the aluminum (column 11, lines 9-16). No difference is seen between the instantly claimed invention and that of Iwasaki et al.

Claims 1-3, 6, 13, 23, and 27-28 are rejected under 35 U.S.C. 102(b) as being anticipated by Dai et al. (USPN 6,232,706 B1).

Dai et al. teach a process for the growth of aligned carbon nanotubes perpendicular to a substrate. The substrate is preferably macro porous silicon, although it may be nonporous silicon or quartz. A layer, or coating, of nanoporous silicon is applied on the surface of the substrate. The catalyst, preferably iron oxide, is loaded onto this nanoporous layer. The nanotubes are then grown by chemical vapor deposition of a hydrocarbon gas, such as ethylene, at a temperature of about 700°C. No difference is seen between the instantly claimed invention and that of Dai et al.

Claims 1-4, 6-8, 10-14, 20-22, and 27-28 are rejected under 35 U.S.C. 102(b) as being anticipated by Li et al. ("Highly-ordered carbon nanotube arrays...").

Li et al. teach a process for the growth of carbon nanotubes aligned perpendicular to a substrate. Li teaches that a layer, or coating, of anodized and porous aluminum is applied on the surface of the aluminum substrate. A cobalt catalyst is then electrochemically deposited in the channels of the porous alumina layer, followed by calcining at about 600°C to reduce the catalyst, followed by growth of carbon nanotubes by the chemical vapor deposition of a hydrocarbon gas, such as acetylene, at a temperature of about 650°C. The thickness of the porous layer of the example is about 6 microns and the diameter of the channels of the example is 32 nm. Because the metal particles are deposited in the channels, the metal particles have a size of at most 32 nm. No difference is seen between the instantly claimed invention and that of Li et al.

Claims 8, 9, and 20 are rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Iwasaki et al.

Iwasaki et al. is applied above. Iwasaki et al. do not explicitly teach the particles size of the cobalt catalytic material. However, it is expected that the cobalt particles have sizes within the claimed ranges because the particles are deposited inside nanoscale diameter channels and because the nanotubes, which are grown from the catalytic particles and are known to have diameters corresponding to the diameter of the catalyst particles from which they are grown, have diameters ranging from 2nm to 50nm. Alternatively, it would have been obvious to one of

ordinary skill at the time of invention to control the diameter of the channels, as taught by Iwasaki et al., in order to allow for catalyst particles, and thus nanotubes, of a desired diameter.

Claims 8-9 are rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Dai et al.

Dai et al. is applied above. Dai et al. do not explicitly teach the particle size of the metal catalysts. However, Dai et al. teach that the nanotubes grown from these particles have diameters of about 16 nm. It is expected that the metal particles have corresponding diameters because it is known that nanotube diameters correspond to the size of the catalyst particles from which they are grown. Alternatively, it would have been obvious to one of ordinary skill at the time of invention to use metal particles of between 1-20 nm in order to grow nanotubes with corresponding diameters.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 25 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iwasaki et al.

Iwasaki is applied above. Iwasaki et al. does not explicitly teach the process of heating the ceramic substrate to dry prior to the application of the aluminum film. It would have been obvious to one of ordinary skill at the time of invention to do so, however, in order to ensure a uniform film.

Claims 24 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iwasaki et al. as applied above, and further in view of Ohki et al.

Iwasaki et al. teach the use of a variety of substrates, including silicon compounds materials. Iwasaki et al. do not explicitly teach the use of a silica-alumina substrate. Ohki et al. teach a similar process for the production of aligned carbon nanotube films. Ohki et al. teach the preferred use of a silica-alumina substrate as it has the ability to withstand damage from the high temperatures needed for nanotube growth. It would have been obvious to one of ordinary skill at the time of invention to have used the silica-alumina film of Ohki et al. as the substrate of Iwasaki et al. in order to benefit from the heat endurance capability of the material.

Claims 4-5, 7-9, and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dai et al.

Dai et al. is applied above. Dai et al. do not explicitly teach the coating thickness of the nanoporous silicon layer, however, the layer is formed by electrochemical etching, by which the thickness of the nanoporous layer can be controlled. The optimum thickness of the nanoporous layer, therefore, could have been determined through routine experimentation, and is held to be obvious by *In re Boesch* 205 USPQ 215.

While Dai et al. teach that the catalyst is loaded on the nanoporous layer by physical vapor deposition, they also teach that catalyst materials can be deposited as iron salts dissolved in a carrier solvent (column 5, lines 44-50), such as by dipping or impregnation. It would have been obvious to one of ordinary skill at the time of invention to replace the vapor deposition process of Dai et al. with the impregnation of the nanoporous layer with an iron salt solution, as it will result in an equivalent loading of the catalyst, while eliminating the temperatures needed for vapor deposition.

Additionally, Dai et al. do not explicitly teach the use of a cobalt catalyst. However, as cobalt catalysts are known to be equivalent to iron catalysts for producing carbon nanotubes by chemical vapor deposition, it would have been obvious to one of ordinary skill at the time of invention to substitute a cobalt catalyst for the iron catalyst of Dai et al.

Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dai et al. as applied above and further in view of Ohki et al. (USPN 6,545,396).

Dai et al. teach that the method of growing aligned carbon nanotubes may be performed using substrates such as ceramics, alumina, sapphire, and silica, for example. The primary condition being that the substrate material must be able to tolerate the high temperatures used in the chemical vapor deposition process (column 5, lines 56-63). Dai does not specifically teach the use of a silica-alumina substrate.

Ohki et al. teach the chemical vapor deposition growth of aligned carbon nanotubes over a substrate. Ohki et al. teach that the substrate is preferably an alumina-silica mixture because the ceramic substrate may thus withstand the temperatures, 500-1000°C, needed for nanotube

growth (column 4, lines 55-60). It would have been obvious to one of ordinary skill at the time of invention to use a silica-alumina substrate, as taught by Ohki et al., in the process of Dai et al. in order to provide an equivalent substrate which may withstand high temperature treatment.

Claims 5, 9, and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li et al. as applied to claims 1-4, 6-8, 10-14, 20-22, and 27-28 above, and further in view of Moskovits et al. (USPN 6,129,901).

Li et al. teach that varying anodizing conditions may control the thickness or channel diameter of the porous alumina layer. Li et al., however, do not teach the range in which these properties may be varied.

Moskovits et al. teach an equivalent process, wherein the porous alumina film may be controlled to a thickness of between 1-100 microns. Moskovits et al. also teach that the average pore channel diameter of the porous alumina film may be controlled to be 20 nanometers (column 3, lines 20-39). It would have been obvious to one of ordinary skill at the time of invention to control the thickness of the layer and the average diameter of the channels to within a given range, as it corresponds to the length and diameters of the carbon nanotubes which are grown from this layer.

Li et al. also does not explicitly teach the details of the electrochemical deposition of the cobalt catalyst. Moskovits et al., however, teach that the electrochemical deposition of the cobalt catalyst may be achieved in a bath containing an aqueous solution of cobalt sulfate (column 3, lines 40-55). It would have been obvious to one of ordinary skill at the time of invention to apply the electrochemical deposition of the cobalt catalyst from a cobalt sulfate solution, as

taught by Moskovits et al., in the process of Li et al. in order to ensure an appropriate catalyst loading.

Allowable Subject Matter

Claims 16-19 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Peter J Lish whose telephone number is 703-308-1772. The examiner can normally be reached on 9:00-6:00 Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stanley Silverman can be reached on 703-308-3837. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-305-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

PL
May 27, 2003

STUART L. HENDRICKSON
PRIMARY EXAMINER